ROUX

MEMORANDUM

Date: September 25, 2018

To: Mike Cirian, USEPA

From: Laura Jensen, Roux

CC: John Stroiazzo, Glencore
Steve Wright, CFAC
Dick Sloan, MDEQ
Andrew Baris, Roux
Michael Ritorto, Roux
Gary Long, EHS Support, LLC

Subject: **Technical Memorandum: Proposed Refined Ecological Screening Values to Support the Baseline Ecological Risk Assessment at the Columbia Falls Superfund Site**
Former Columbia Falls Aluminum Company Aluminum Reduction Facility
Columbia Falls, Montana

On behalf of Columbia Falls Aluminum Company, LLC (CFAC), Roux Environmental Engineering and Geology, D.P.C. (Roux) and EHS Support, LLC prepared the attached Technical Memorandum for Proposed Refined Ecological Screening Values (ESVs) to Support the Baseline Ecological Risk Assessment (BERA) for the CFAC Superfund Site in Columbia Falls, Montana. This memorandum has been prepared as part of the ongoing Remedial Investigation/Feasibility Study (RI/FS) being conducted pursuant to the Administrative Settlement Agreement and Order on Consent (AOC) dated November 30, 2015 between CFAC and the United States Environmental Protection Agency (USEPA) (CERCLA Docket No. 08-2016-0002).

Should there be any questions or comments on this submission, please do not hesitate to contact me at (631) 230-2300.

Sincerely,

Laura Jensen

Laura Jensen, P.G. (NY)
Project Hydrogeologist

MEMO

To: Andrew Baris, Roux

From: Gary Long

CC: Michael Ritorto, Roux
Laura Jensen, Roux
Tom Biksey, EHS Support

Date: September 25, 2018

Re: *Technical Memorandum: Proposed Refined Ecological Screening Values (ESVs) to Support the Baseline Ecological Risk Assessment at the Columbia Falls Superfund Site*
Former Columbia Falls Aluminum Company Aluminum Reduction Facility
Columbia Falls, Montana

Introduction

This technical memorandum describes the approach for developing refined ecological screening values (ESVs) to support the selection of constituents of potential ecological concern (COPECs) in the Baseline Ecological Risk Assessment (BERA) for the Columbia Falls Aluminum Company (CFAC) Superfund Site in Columbia Falls, Montana. This technical memorandum was prepared as an interim deliverable to supplement the general risk assessment framework provided in the *Baseline Ecological Risk Assessment Work Plan* (BERA WP) submitted to the United States Environmental Protection Agency (USEPA) and Montana Department of Environmental Quality (MDEQ) in November 2017 and revised in May 2018 (EHS Support, 2018a).

As stated in the BERA WP, refinement of COPECs identified in the Screening-Level Ecological Risk Assessment (SLERA) will be performed as part of the BERA Problem Formulation (EHS Support, 2018a). COPEC refinement in the BERA Problem Formulation is consistent with USEPA *The Role of Screening-Level Risk Assessments and Refining Contaminants of Concern in Baseline Ecological Risk Assessment* (USEPA, 2001). The refinement of COPECs identified in the SLERA is a fundamental step in the BERA Problem Formulation to focus BERA analyses on COPECs that are most likely to drive risk management decision-making for the Site. The intent of the refinement is to focus and streamline the overall Ecological Risk Assessment Guidance for Superfund (ERAGS) process by considering additional components early in the BERA process.

COPEC refinement will be performed on the combined datasets from the Phase I and Phase II Site Characterization sampling for ecological exposure media (EHS Support, 2018a). Screening of constituents using the combined Phase I and Phase II datasets for each exposure area and exposure medium will be based on a tiered approach:

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1) Maximum exposure point concentrations (EPCs) of constituents in Phase I and Phase II Site Characterization datasets for each ecological exposure area will be initially compared to minimum ESVs presented in the SLERA.
2) Constituents identified as COPECs in the initial screening will be refined based on the re-screening of COPECs using comparisons of maximum EPCs to refined ESVs.

The technical memorandum presents the rationale for selecting refined ESVs to support the COPEC refinement process in the BERA. The comparisons of maximum exposure concentrations to minimum ESVs, consistent with Step 1 of the COPEC refinement process, have a low probability of resulting in false negatives in the screening process (i.e., eliminating COPECs that may cause adverse effects due to exposure). However, the minimum ESVs applied in Step 1 of the screening do not represent the range of no observed effect concentration (NOEC) endpoints that are protective of chronic exposure. Therefore, these comparisons cannot be used to conclude that exposure to a COPEC is likely to result in adverse effects. The findings of Step 1 of the screening process only indicate that certain COPECs and associated exposure pathways require further evaluation. Refined ESVs were identified to represent values that are protective of chronic exposure but represent a broader range of NOEC endpoints that will be used to focus the list of COPECs requiring further evaluation in the BERA.

Refined ESVs are identified in this technical memorandum for the list of COPECs identified for soil, sediment, and surface water in the SLERA based on the screening of Phase I Site Characterization data and additional COPECs identified in the BERA WP based on detected constituents lacking ESVs. If additional COPECs are identified during Tier 1 screening once the Phase I and Phase II Site Characterization datasets are combined, the selection of refined ESVs for the Tier 2 screening will follow the approach outlined in this technical memorandum for additional COPECs. The following sections describe the technical rationale for the selection of refined soil, sediment, and surface water ESVs in the COPEC refinement process in the BERA Problem Formulation.

Refined Soil ESVs

Refined soil ESVs will be based on peer-reviewed, multi-trophic level soil screening criteria, consistent with the USEPA approach for deriving Ecological Soil Screening Levels (Eco-SSLs). Eco-SSLs were derived as risk-based soil screening levels through a peer review process for the protection of multiple terrestrial receptor categories (USEPA, 2005):

- Terrestrial plants
- Soil invertebrates
- Birds
- Mammals

Like Eco-SSLs, the Los Alamos National Laboratory (LANL) ECORISK Database (Release 4.1) presents conservative screening values based on modeled exposure for receptors in various trophic levels (LANL, 2017). Consistent with the Eco-SSL approach, the ECORISK Database used geometric mean concentrations of NOEC endpoints as screening criteria for each terrestrial receptor category. These LANL screening values were used to supplement the Eco-SSL values to develop refined ESVs. Screening values for the various terrestrial trophic level receptors evaluated in both the ECORISK Database and the Eco-SSL guidance were pooled, and the minimum screening criterion for each COPEC was identified as the refined soil ESV (**Table 1**).

Refined ESVs for chemicals lacking screening values in the LANL and/or Eco-SSL datasets were identified from other available sources in the literature. USEPA Region 5 ecological screening levels (ESLs) (USEPA, 2003a) were preferentially used for this purpose. ESLs provide protective benchmarks for contaminants in soil, and consider direct, as well as indirect (i.e., food-chain) exposure pathways. If ESLs were not available, other accepted sources for soil benchmarks were also considered (e.g., Efroymson et al., 1997a; Efroymson et al., 1997b).

Given that refined ESVs are protective of direct contact and indirect ingestion exposure pathways, constituents with maximum EPCs lower than the refined ESVs will not be evaluated further in the BERA. In the absence of sufficient data to refine soil ESVs, the conservative minimum ESV used in the SLERA will be retained. However, further literature review may be conducted to refine ESVs for these COPECs in the BERA Problem Formulation. Refined soil ESVs for the initial COPECs identified in the SLERA and BERA Work Plan are presented in **Table 1**; the rationale for the selection of refined ESVs is presented in the following sections.

Inorganic COPECs

With one exception, the lowest screening value from the LANL ECORISK Database or the USEPA Eco-SSLs will be used as refined ESVs for metal and other inorganic COPECs (**Table 1**). The refined ESV for chromium was the only metal for which the lowest screening value from the two primary sources was not selected.

Refined ESVs for chromium will be identified from toxicity studies conducted based on exposure to the corresponding form of chromium measured in soils at the Site. Chromium is present primarily in the trivalent [Cr(III)] oxidation state under typical soil conditions (USEPA, 2008a). Hexavalent chromium [Cr(VI)] is only stable in oxidizing soils at moderate pH levels, whereas the Cr(III) is the dominant species under moderately oxidizing to reducing conditions. Additionally, the reduction-oxidation transformations between the two valence states are not fully reversible. Cr(VI) will reduce to Cr(III) in a reducing environment, but once reduced, Cr(III) will not readily re-oxidize to Cr(VI) under oxidizing conditions. Soil conditions at CFAC are not strongly oxidizing and a waste stream that would deposit Cr(VI) directly into soils has not been identified at the CFAC facility (Roux Associates, 2017).

A select number of soil borings will be analyzed for Cr(VI) and total chromium in the Phase II Site Characterization to reduce uncertainty in the risk assessment of chromium in site soils (Roux Associates, 2018a). Cr(III) concentrations will be estimated as the difference in concentrations between total chromium and Cr(VI) results. Estimated concentrations of Cr(III) and measured concentrations of Cr(VI) will be used to develop a site-specific ratio of Cr(III):Cr(VI). The site-specific Cr(III):Cr(VI) ratio will be applied to Phase I and Phase II samples analyzed only for total chromium to estimate the relative concentration of Cr(III) and Cr(VI) in the sample. Refined ESVs derived based on Cr(VI) toxicity studies will be applied to the measured or estimated Cr(VI) concentrations in soil; refined ESVs for Cr(III) or total chromium will be applied to estimated concentrations of Cr(III) in soil (**Table 1**).

Numeric ESVs were not identified for aluminum and iron in soil in the Eco-SSL or LANL ECORISK database. USEPA Eco-SSL guidance indicates that total aluminum measurements are not considered suitable or reliable for the prediction of potential toxicity and bioaccumulation of aluminum in soils (USEPA, 2003b). The Eco-SSL guidance indicates that potential ecological risks associated with aluminum are based on soil pH, with aluminum being identified as a COPEC only at sites where soil pH is less than 5.5 (USEPA, 2003b). Therefore, the screening of aluminum as a COPEC in site soils will be based on measured soil pH values as an indication of the potential bioavailability and toxicity of aluminum concentrations. Like aluminum, numeric Eco-SSLs were not derived for iron because its bioavailability and toxicity are dependent upon site-specific conditions, including soil pH. In well-aerated soils with pH values between 5 and 8, iron is not expected to be toxic to plants (USEPA, 2003c). Consistent with Eco-SSL guidance, the potential bioavailability and toxicity of iron will be based on site-specific measurements of soil pH.

For metal COPECs, mean concentrations representative of unimpacted soils analyzed as part of the Montana State Background Investigation (MSBI; Hydrometrics, 2013) were presented in the BERA Work Plan to provide regional context to concentrations of inorganic chemicals detected in soil. Further characterization of background conditions is proposed as part of the Phase II Site Characterization (Roux Associates, 2018b; Roux Associates, 2018c). Site-specific background data collected as part of the Phase II Site Characterization will supplant MSBI regional soil data in the COPEC refinement process conducted as part of the BERA Problem Formulation. In addition to comparisons to refined ESVs, concentrations of metals in soil will also be compared to representative, site-specific background concentrations to evaluate whether detected concentrations are consistent with naturally occurring concentrations.

As stated in the BERA Work Plan and consistent with *The Role of Screening-Level Risk Assessments and Refining Contaminants of Concern in Baseline Ecological Risk Assessments* (USEPA, 2001), representative background concentrations calculated from Phase II Site Characterization background data will be used as the refined ESV to evaluate the need for further consideration of essential nutrients in the BERA. Because the soil background data from the Phase II Site Characterization sampling have not been compiled and representative background concentrations for each metal have not yet been calculated or approved, only the refined ESVs based on toxicological effects are presented in this interim deliverable.

Organic COPECs

LANL and/or USEPA Eco-SSLs values were available for many organic COPECs (**Table 1**). For the organic COPECs lacking LANL or Eco-SSL values, refined ESVs will be based on USEPA Region 5 ESLs (USEPA, 2003a) for 16 non-polycyclic aromatic hydrocarbons (PAH) organic compounds and based on an Oak Ridge National Laboratory (ORNL) benchmark for 4-nitrophenol in soil (Efroymson et al., 1997a). As shown in **Table 1**, the minimum ESV used in the SLERA was retained for organic COPECs lacking refined ESVs from these sources.

Exposure to the mixture of 17 dioxin/furan compounds analyzed in surficial (0-0.5 ft) and shallow (0.5-2 ft) soil samples will be evaluated relative to the toxicity of 2,3,7,8-tetrachlorinated dibenzo-p-dioxin (2,3,7,8-TCDD) using toxicity equivalency factors (TEFs) developed for birds and mammals by the World Health Organization (Van den Berg et al., 2006; Van den Berg et al., 1998; USEPA, 2008b). For dioxin/furan screening, measured concentrations of the 17 dioxin/furan compounds in surface and shallow soil samples will be multiplied by compound-specific TEFs to calculate toxicity equivalence concentrations to 2,3,7,8-TCDD ($TEC_{2,3,7,8\text{-TCDD}}$) for each compound, assuming consistent bioaccumulation for the 17 dioxin/furan compounds. The summed $TEC_{2,3,7,8\text{-TCDD}}$ values for each sample will be compared to the refined ESV for 2,3,7,8-TCDD, which is identified in **Table 1** as 0.00000029 mg/kg based on the protection of mammalian wildlife in the LANL ECORISK database. In the $TEC_{2,3,7,8\text{-TCDD}}$ calculation, dioxin/furan concentrations below detection limits will be estimated as 0.5 times the quantitation limit for constituents that were detected in at least one other sample in the soil dataset; constituents that were below detection limits in all soil samples will be assigned a concentration of 0 in the $TEC_{2,3,7,8\text{-TCDD}}$ calculation (USEPA, 2008b).

Given that some organic COPECs in soils may be derived from regional sources unrelated to site activities (e.g., PAHs), representative background concentrations derived from the background investigation that will be conducted as part of the Phase II Site Characterization sampling will be compared to measured concentrations in site datasets to further refine the list of organic COPECs for evaluation in the BERA (Roux Associates, 2018c).

Refined Sediment ESVs

Refined ESVs for sediment will be based primarily on consensus-based criteria and equilibrium partitioning (EqP)-based criteria protective of direct contact toxicity pathways to benthic organisms. Given that sediment ESVs are not derived for the protection of indirect exposure through ingestion (e.g., bioaccumulation/biomagnification pathways), potential ingestion exposure pathways for detected bioaccumulative COPECs will be evaluated consistent with the approach outlined in the *Technical Memorandum: Proposed Wildlife Exposure Modeling Approach to Support the Baseline Ecological Risk Assessment at the Columbia Falls Superfund Site* (EHS Support, 2018b).

Refined ESVs for sediment COPECs identified in the SLERA and BERA Work Plan are provided in **Table 2**; the rationale for the selection of refined ESVs is presented in the sections below. In the absence of sufficient data to refine sediment ESVs, the conservative minimum ESV used in the SLERA will be retained. However, further literature review may be conducted to refine ESVs for these COPECs in the BERA Problem Formulation.

Inorganic COPECs

Refined sediment ESVs for metal COPECs will be using the consensus-based threshold effects concentrations (TEC) approach (MacDonald et al., 2000), as available. In the absence of consensus-based TECs, refined ESVs will be selected from sources in the following order of preference:

- USEPA Region 5 ESLs
- USEPA Region 3 Biological Technical Assistance Group (BTAG) Freshwater Sediment Screening Benchmarks
- Threshold Effect Levels (TELs) for *Hyalella azteca* (USEPA, 1996; Ingersoll et al., 1996)

The refined ESV for total cyanide of 0.1 mg/kg will be based on the USEPA Region 3 BTAG screening value, which was adopted from Persaud et al. (1993). The minimum ESV previously used in the SLERA (0.0001 mg/kg) was based on the USEPA Region 5 ESL for total cyanide, which also cited Persaud et al. (1993) as a source. However, USEPA Region 5 erroneously presented the Persaud et al. (1993) value as 0.0001 mg/kg. Therefore, the correct value of 0.1 mg/kg from Persaud et al. (1993) will be used as the refined ESV for total cyanide in sediment.

Inorganic COPECs in sediment will also be evaluated relative to site-specific background data collected as part of the Phase II Site Characterization to further refine sediment COPECs in the BERA (Roux Associates, 2018c). As stated in the BERA Work Plan and consistent with USEPA (2001), representative background concentrations calculated from Phase II Site Characterization background data will be used as the refined ESV to evaluate the need for further consideration of essential nutrients in the BERA (**Table 2**).

Organic COPECs

Refined ESVs for organic COPECs in sediment will be based primarily on EqP-based criteria protective of direct contact toxicity pathways to benthic organisms. Refined ESVs for PAHs in sediment will be based on USEPA *Procedures for the Derivation of Equilibrium Partitioning Sediment Benchmarks (ESBs) for the Protection of Benthic Organisms: PAH Mixtures* (USEPA, 2003d). Exposure to PAH mixtures in sediment will be evaluated for potential additive narcotic effects to benthic organisms based on the sum of equilibrium partitioning sediment benchmark toxic units (∑ESBTUs) calculated from individual PAH compounds:

$$\sum ESBTU_{FCV,Total} = \sum_{i=1}^{16} \frac{C_{oc,PAHi}}{C_{oc,PAHi,FCVi}} \times UF$$

where:

$\sum ESBTU_{FCV,Total}$	= Sum of ESBTUs for the PAH mixture based on 34 PAH compounds (unitless)
$C_{oc,PAHi}$	= Organic carbon normalized concentration of PAH *i* (µg/g_{oc})
$C_{oc,PAHi,FCVi}$	= Organic carbon normalized critical concentration of PAH *i* based on the final chronic value (FCV; µg/g_{oc})
UF	= Uncertainty factor to estimate the toxicity of total PAHs (based on 34 PAHs – 18 parent and 16 alkylated compounds)

∑ESBTU values less than or equal to 1.0 are considered acceptable for the protection of benthic invertebrate receptors; values exceeding 1.0 indicate a potential for narcotic effects in benthic receptors (USEPA, 2003d).

Sediment samples collected in the Phase I Site Characterization were analyzed for 16 of the 34 PAH compounds included in the USEPA ESB model[1]; therefore, for the Phase I data, a site-specific uncertainty factor (UF) or site-specific relationship will be applied to the ∑ESBTU values calculated based on 16 compounds ($\sum ESBTU_{FCV,16}$) to estimate $\sum ESBTU_{FCV,Total}$. Sediment samples collected from select stations in the Phase II Site Characterization sampling will be analyzed for the 34 PAH compounds included in the USEPA ESB model; therefore, $\sum ESBTU_{FCV,Total}$ values will be calculated directly based on the concentrations of the 34 PAH compounds measured in these samples.

[1] Analyzed PAH compounds include: naphthalene, acenaphthylene, acenaphthene, fluorene, anthracene, phenanthrene, pyrene, fluoranthene, benz(a)anthracene, chrysene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(g,h,i)perylene, indeno(1,2,3-cd)pyrene, dibenzo(a,h)anthracene.

Site-specific relationships will be developed to estimate the potential toxicity of unmeasured PAHs in the ∑ESBTU calculation in samples where only 16 compounds were analyzed. Site-specific relationships will be evaluated between ∑ESBTU values calculated based on 34 compounds ($\sum ESBTU_{FCV,34} = \sum ESBTU_{FCV,Total}$) and 16 compounds ($\sum ESBTU_{FCV,16}$). Site-specific ratios of $\sum ESBTU_{FCV,34}$:$\sum ESBTU_{FCV,16}$ may be developed as UFs to account for unmeasured PAHs in samples analyzed for 16 PAH compounds. The development of UFs based on $\sum ESBTU_{FCV,34}$:$\sum ESBTU_{FCV,16}$ ratios is consistent with the estimation of UFs in USEPA (2003d); however, the use of site-specific ratios provides more relevant UFs for PAH mixtures at the Site. Alternatively, $\sum ESBTU_{FCV,Total}$ values may be estimated using site-specific linear regression models developed based on paired $\sum ESBTU_{FCV,16}$ and $\sum ESBTU_{FCV,34}$ values at stations where 34 PAH compounds are analyzed, provided a significant linear relationship can be derived. The use of site-specific relationships to predict $\sum ESBTU_{FCV,34}$ from $\sum ESBTU_{FCV,16}$ in historical samples is intended to reduce the uncertainty of applying generic UFs provided in USEPA (2003d) to account for the potential toxicity of unmeasured PAHs in the ∑ESBTU calculation.

The availability of ESVs for non-PAH semi-volatile organic compound (SVOC) COPECs is limited (**Table 2**). An EqP-based sediment benchmark provided in USEPA (2008c) will be used as a refined ESV for dibenzofuran. An EqP-based sediment benchmark for 4-methylphenol adopted by USEPA Region 5 as an ESL will be used as a refined ESV for 3- & 4-methylphenol. The EqP-based sediment benchmark for 4-methylphenol was lower than the USEPA Region 5 EqP-based sediment benchmark for 3-methylphenol; therefore, the refined ESV will be conservative based on the assumption that the 3- & 4-methylphenol concentration consists entirely of 4-methylphenol.

ESVs were not identified for other non-PAH SVOC COPECs. However, refined ESVs may be calculated using an EqP model if the review of the combined Phase I and Phase II Site Characterization data indicates frequent detection of these non-PAH SVOC COPECs (greater than 5 percent of samples[2]). For select nonionic organic constituents, refined ESVs will be based on sediment quality benchmarks (SQBs) calculated using an EqP model (USEPA, 2008c). SQBs represent concentrations in bulk sediment that, at equilibrium, would result in partitioning to sediment pore water at concentrations equivalent to NOEC water quality benchmarks (WQB_{NOEC}) based on constituent-specific organic carbon-water partitioning coefficients (K_{oc}):

$$SQB_{NOEC} = (f_{oc} \times K_{oc} \times WQB_{NOEC})$$

where:

SQB_{NOEC}	= Sediment quality benchmark based on NOEC aqueous toxicity data (µg/kg dry weight sediment)
f_{oc}	= fraction of organic carbon (kg OC/kg sediment)
K_{oc}	= organic carbon-water partitioning coefficient (L/kg)
WQB_{NOEC}	= water quality benchmark based on a chronic NOEC (µg/L)

[2] USEPA (2001) provides for the refinement of COPECs based on frequency and magnitude of detection. Assuming the Phase I and Phase II Site Characterization data provide adequate coverage, a frequency of detection of less than 5 percent in site datasets will be used to refine COPECs from further consideration in the BERA, as proposed in the BERA WP (EHS Support, 2018a).

For select nonionic organic constituents, refined ESVs will be based on SQBs calculated assuming minimum f_{oc} within the exposure area and WQB_{NOEC} values based on surface water quality benchmarks derived for the general protection of aquatic life. Exposure estimates for COPECs exceeding SQBs calculated assuming minimum f_{oc} within the exposure area will be further evaluated based on sample-specific f_{oc} in the BERA exposure assessment. In the absence of sufficient data to refine sediment ESVs based on EqP approaches, the conservative minimum ESV used in the SLERA will be retained.

Refined Surface Water ESVs

Refined ESVs for surface water will be primarily based on USEPA National Recommended Water Quality Criteria (NRWQC) or MDEQ chronic surface water quality for the protection of aquatic life (**Table 3**). Chronic aquatic life surface water criteria are derived for the protection of 95 percent of aquatic species. Therefore, these criteria are considered adequately protective to identify COPEC concentrations in surface water that have the potential to result in adverse ecological effects and warrant additional evaluation in the BERA.

Inorganic COPECs

Refined surface water ESVs for metal COPECs will be based on USEPA NRWQC or MDEQ chronic surface water quality for the protection of aquatic life, where applicable. Refined surface water ESVs for metal COPECs will be applied to the sample result fraction (total versus dissolved) that corresponds to the aqueous toxicity endpoint (total versus dissolved) used as the basis for chronic aquatic life surface water criteria.

For USEPA NRWQC, chronic surface water quality criteria for many metals are based on exposure to the dissolved fraction (**Table 3**). Refined ESVs for these metals will be compared to metals concentrations in surface water samples filtered through a 0.45-µm pore size filter, which operationally defines the dissolved COPEC fraction. USEPA NRWQC for cadmium, lead, nickel, and zinc are adjusted for total hardness (as $CaCO_3$) using the equations provided in **Table 3**. USEPA NRWQC for copper and aluminum are based on models developed to characterize the bioavailable forms of these metals in surface water based on water quality parameters. The NRWQC for copper is based on the Biotic Ligand Model (BLM), which accounts for organic compounds and inorganic ligands in surface water that are known to complex with copper and affect bioavailability and toxicity (USEPA, 2007b). For aluminum, the refined ESV will be based on draft USEPA aquatic life ambient water quality criteria developed using multiple linear regression models to characterize aluminum bioavailability based on pH, hardness, and dissolved organic carbon (DOC; USEPA, 2017).

MDEQ Aquatic Life Standards (DEQ-7) for metals are based on the total (unfiltered) fraction, except for aluminum. MDEQ criteria for cadmium, copper, lead, nickel, and zinc will be adjusted for total hardness (as $CaCO_3$) using the equations provided in **Table 3**.

Refined ESVs for metals will be based on NRWQC or MDEQ criteria applicable to the sample result fraction (total versus dissolved). If the maximum EPC exceeds the applicable criterion for the corresponding fraction, the metal COPEC will be further evaluated in the BERA.

For metals that lack USEPA NRWQC or MDEQ surface water quality criteria (beryllium and manganese), refined ESVs will be based on lowest chronic values reported for all organisms (fish, daphnids, non-daphnid invertebrates, and aquatic plants) in Suter and Tsao (1996). A revised surface water ESV was not identified for barium; therefore, the minimum ESV used in the SLERA will be used as the basis for further evaluation in the BERA.

ESVs for cyanide and fluoride will be based on minimum ESVs used in the SLERA. The NRWQC criterion for cyanide is based on free cyanide analysis, which represents the concentration of the cyanide ion (CN^-) and hydrogen cyanide (HCN). The MDEQ surface water quality criterion for cyanide is based on total cyanide analysis. If the maximum EPC for free cyanide or total cyanide analyses exceed the applicable criterion, cyanide exposure in surface water will be further evaluated in the BERA.

Inorganic COPECs in surface water will also be evaluated relative to site-specific background data collected as part of the Phase II Site Characterization to further refine surface water COPECs in the BERA.

Organic COPECs

Select PAH compounds were identified as surface water COPECs based on the screening of Phase I Site Characterization and additional COPECs identified in the BERA WP based on detected constituents lacking ESVs. As indicated in **Table 3**, revised ESVs for select PAH compounds will be based on lowest chronic values reported for all organisms (fish, daphnids, non-daphnid invertebrates, and aquatic plants) in Suter and Tsao (1996). If individual PAH compounds exceed revised ESVs, further evaluation of the potential toxicity of PAH mixtures to aquatic organisms will be further evaluated in the BERA.

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Table 1
Summary of Refined Ecological Screening Values (ESVs) for Soil
Technical Memorandum: Proposed Refined Ecological Screening Values
Columbia Falls Aluminum Company
Columbia Fall, Montana

Analyte	CAS Number	Minimum CFAC SLERA ESV	Refined CFAC BERA ESV	Montana State Background Investigation Mean Concentration	Plants					Soil Invertebrates					Mammals					Birds			
					USEPA Eco-SSLs	LANL EcoRisk	ORNL	USEPA Region 5 ESLs	Refined CFAC Plant ESV	USEPA Eco-SSLs	LANL EcoRisk	ORNL	USEPA Region 5 ESLs	Refined CFAC Invertebrate ESV	USEPA Eco-SSLs	LANL EcoRisk	ORNL	USEPA Region 5 ESLs	Refined CFAC Mammalian ESV	USEPA Eco-SSLs	LANL EcoRisk	ORNL	Refined CFAC Bird ESV
Metals (mg/kg)																							
Aluminum	7429905	50	See Narrative	15500	See Narrative	---	50	---	See Narrative	See Narrative	---	---	---	See Narrative	See Narrative	---	---	---	See Narrative	See Narrative	---	---	See Narrative
Antimony	7440360	0.142	0.27	0.2	---	11	5	---	11	78	78	---	---	78	0.27	2.3	0.248	0.142	0.27	---	--	---	---
Arsenic	7440382	0.25	6.8	11.4	18	18	10	---	18	---	6.8	60	---	6.8	46	19	0.25	5.7	19	43	15	2	15
Barium	7440393	1.04	110	195	---	110	500	---	110	330	330	---	---	330	2000	1800	20	1.04	1800	---	720	17.2	720
Beryllium	7440417	1.06	2.5	0.7	---	2.5	10	---	2.5	40	40	---	---	40	21	35	2.42	1.06	21	---	--	---	---
Cadmium	7440439	0.00222	0.27	0.3	32	32	4	---	32	140	140	20	---	140	0.36	0.27	3.533	0.00222	0.27	0.77	0.29	1.2	0.29
Chromium (trivalent)	7440473	0.35	23	19.6	---	---	---	---	---	---	---	---	---	---	34	63	---	---	34	26	23	---	23
Chromium (hexavalent)	7440473	NE	0.34	---	---	0.35	1	---	0.35	---	0.34	0.4	0.4	0.4	130	510	---	---	130	---	140	---	140
Cobalt	7440484	0.14	13	7.3	13	13	20	---	13	---	---	---	---	---	230	240	---	0.14	230	120	76	---	76
Copper	7440508	5.4	14	17.6	70	70	100	---	70	80	80	50	---	80	49	42	55.7	5.4	42	28	14	38.9	14
Iron	7439896	No ESV	See Narrative	18200	See Narrative	---	---	---	See Narrative	See Narrative	---	---	---	See Narrative	See Narrative	---	---	---	See Narrative	See Narrative	---	---	See Narrative
Lead	7439921	0.0537	11	15.3	120	120	50	---	120	1700	1700	500	---	1700	56	93	29.3	0.0537	56	11	11	0.94	11
Manganese	7439965	220	220	508	220	220	500	---	220	450	450	---	---	450	4000	1400	322	---	1400	4300	1300	825	1300
Mercury	7439976	0.005	0.013	0.05	---	34	0.3	---	34	---	0.05	0.1	0.1	0.05	---	1.7	4.76		1.7	---	0.013	0.37	0.013
Nickel	7440020	9.7	10	16.6	38	38	30	---	38	280	280	200	---	280	130	10	146.52	13.6	10	210	20	64.08	20
Selenium	7782492	0.0276	0.52	0.4	0.52	0.52	1	---	0.52	4.1	4.1	70	---	4.1	0.63	0.7	0.733	0.0276	0.63	1.2	0.71	0.331	0.71
Thallium	7440280	0.027	0.05	0.25	---	0.05	1	---	0.05	---	---	---	---	---	---	0.42	0.027	0.0569	0.42	---	4.5	---	4.5
Vanadium	7440622	0.714	4.7	30.9	---	60	2	---	60	---	---	---	---	---	280	290	0.714	1.59	280	7.8	4.7	9.439	4.7
Zinc	7440666	6.62	46	60.5	160	160	50	---	160	120	120	200	6.62	120	79	99	586.1		79	46	47	12	46
Essential Nutrients (mg/kg)																							
Calcium	7440702	No ESV	Background	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Magnesium	7439954	No ESV	Background	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Potassium	7440097	No ESV	Background	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Sodium	7440235	No ESV	Background	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Other Inorganic Parameters (mg/kg)																							
Cyanide, Total	57125	0.1	0.098	---	---	---	---	---	---	---	---	---	---	---	---	330	---	1.33	330	---	0.098	---	0.098
Fluoride	16984488	6.5	120	---	---	---	---	---	---	---	---	---	---	---	---	1100	149.4	---	1100	---	120	6.5	120
Polycyclic Aromatic Hydrocarbons (PAHs) (mg/kg)																							
Total LMW PAHs	NA	29	29	---	---	---	---	---	---	29	---	---	---	29	100	---	---	---	100	---	---	---	---
Total HMW PAHs	NA	1.1	1.1	---	---	---	---	---	---	18	---	---	---	18	1.1	---	---	---	1.1	---	---	---	---
Semi-Volatile Organic Compounds (SVOCs) - Non PAH (mg/kg)																							
1,2,4,5-Tetrachlorobenzene	95943	2.02	2.02	---	---	---	---	---	---	---	---	---	---	---	---	--	---	2.02	2.02	---	---	---	---
1.4-Dioxane	123911	1.83	1.83	---	---	---	---	---	---	---	---	---	---	---	---	--	1.83	2.05	1.83	---	---	---	---
2,4,5-Trichlorophenol	95954	4	4	---	---	---	4	---	4	---	---	9	---	9	---	--	---	14.1	14.1	---	---	---	---
2,4-Dimethylphenol	105679	0.01	0.01	---	---	---	---	0.01	0.01	---	---	---	---	---	---	--	---		---	---	---	---	---
2,4-Dinitrophenol	51285	0.0609	0.0609	---	---	---	20	---	20	---	---	---	---	---	---	--	---	0.0609	0.0609	---	---	---	---
2,4-Dinitrotoluene	121142	1.28	6	---	---	6	---	---	6	---	18	---	---	18	---	14	---	1.28	14	---	---	---	---
2,6-Dinitrotoluene	606202	0.0328	4	---	---	---	---	---	---	---	30	---	---	30	---	4	---	0.0328	4	---	52	---	52
2-Chloronaphthalene	91587	0.0122	0.0122	---	---	---	---	---	---	---	---	---	---	---	---	--	---	0.0122	0.0122	---	---	---	---
2-Chlorophenol	95578	0.243	0.39	---	---	---	---	---	---	---	---	---	---	---	---	0.54	---	0.243	0.54	---	0.39	---	0.39
2-Methylphenol	95487	0.67	0.67	---	---	0.67	---	---	0.67	---	---	---	---	---	---	580	---	---	580	---	---	---	---
2-Nitrophenol	88755	1.6	1.6	---	---	---	---	---	---	---	---	---	---	---	---	--	---	1.6	1.6	---	---	---	---
3,3'-Dicholorobenzidine	91941	0.646	0.646	---	---	---	---	---	---	---	---	---	---	---	---	--	---	0.646	0.646	---	---	---	---
4,6-Dinitro-2-methylphenol	534521	0.144	0.144	---	---	---	---	---	---	---	---	---	---	---	---	--	---	0.144	0.144	---	---	---	---
4-Chloroaniline	106478	1	1	---	---	1	---	---	1	---	1.8	---	---	1.8	---	--	---	---	---	---	---	---	---
4-Nitrophenol	100027	No ESV	7	---	---	---	---	---	---	---	---	7	---	7	---	--	---	---	---	---	---	---	---
Bis(2-chloroethoxy) methane	111911	0.302	0.302	---	---	---	---	---	---	---	---	---	---	---	---	--	---	0.302	0.302	---	---	---	---
Bis(2-ethylhexyl) phthalate	117817	0.02	0.02	---	---	---	---	---	---	---	---	---	---	---	---	0.6	36	0.925	0.6	---	0.02	0.91	0.02
Butylbenzylphthalate	85687	0.239	0.239	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Caprolactam	105602	No ESV	No ESV	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Dibenzofuran	132649	6.1	6.1	---	---	6.1	---	---	6.1	---	---	---	---	---	---	--	---	---	---	---	---	---	---
Di-n-butylphthalate	84742	0.011	0.011	---	---	160	200	---	160	---	---	---	---	---	---	180	1090	---	180	---	0.011	0.09	0.011
Di-n-octylphthalate	117840	0.91	0.91	---	---	---	---	---	---	---	---	---	---	---	---	0.91	---	---	0.91	---	---	---	---
Hexachlorobenzene	118741	0.079	0.079	---	---	10	---	---	10	---	10	---	---	10	---	0.2	---	0.199	0.2	---	0.079	---	0.079
Hexachlorobutadiene	87683	0.0398	0.0398	---	---	---	---	---	---	---	---	---	---	---	---	--	---	0.0398	0.0398	---	---	---	---

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					USEPA Eco-SSLs	LANL EcoRisk	ORNL	USEPA Region 5 ESLs	Refined CFAC Plant ESV	USEPA Eco-SSLs	LANL EcoRisk	ORNL	USEPA Region 5 ESLs	Refined CFAC Invertebrate ESV	USEPA Eco-SSLs	LANL EcoRisk	ORNL	USEPA Region 5 ESLs	Refined CFAC Mammalian ESV	USEPA Eco-SSLs	LANL EcoRisk	ORNL	Refined CFAC Bird ESV
Hexachlorocyclopentadiene	77474	0.755	0.755	---	---	---	10	---	10	---	---	---	---	---	---	--	---	0.755	0.755	---	---	---	---
Hexachloroethane	67721	0.596	0.596	---	---	---	---	---	---	---	---	---	---	---	---	--	---	0.596	0.596	---	---	---	---
Nitrobenzene	98953	1.31	2.2	---	---	---	---	---	---	---	2.2	40	---	2.2	---	4.8	---	1.31	4.8	---	---	---	---
N-Nitrosodi-n-propylamine	621647	0.544	0.544	---	---	---	---	---	---	---	---	---	---	---	---	--	---	0.544	0.544	---	---	---	---
N-Nitrosodiphenylamine	86306	0.545	0.545	---	---	---	---	---	---	---	---	20	---	20	---	--	---	0.545	0.545	---	---	---	---
Pentachlorophenol	87865	0.119	0.36	---	5	5	3	---	5	31	31	6	---	31	2.8	0.81	0.879	0.119	0.81	2.1	0.36	---	0.36
Phenol	108952	0.79	0.79	---	---	0.79	70	---	0.79	---	1.8	30	---	1.8	---	37	---	120	37	---	---	---	---
Volatile Organic Compounds (VOCs) (mg/kg)																							
Bromomethane	74839	No ESV	No ESV	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Cyclohexane	110827	No ESV	No ESV	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Isopropylbenzene	98828	No ESV	No ESV	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Methyl acetate	79209	No ESV	No ESV	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Methylcyclohexane	108872	No ESV	No ESV	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
M,P-Xylene	179601231	No ESV	No ESV	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
O-Xylene	95476	No ESV	No ESV	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Total Xylenes	1330207	No ESV	1.4	---	---	100	---	10	100	---	---	---	---	---	---	1.4	4.162	---	1.4	---	41	---	41
Dioxin and Dioxin-Like Compounds (mg/kg)																							
Mammalian $TEC_{2,3,7,8\text{-}TCDD}$	NA	NE	0.00000029	---	---	---	---	---	---	---	5	---	---	5	---	0.00000029	3.15E-07	---	0.00000029	---	---	---	---
Avian $TEC_{2,3,7,8\text{-}TCDD}$	NA	NE	0.00000158	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	0.00000158	0.00000158

Notes:
No ESV, An ecological screening value was not identified from the listed sources.
BERA, Baseline Ecological Risk Assessment
CFAC, Columbia Falls Aluminum Company
Eco-SSL, Ecological Soil Screening Level
ESL, Ecological Screening Level
ESV, Ecological Screening Value
HMW, High Molecular Weight
LANL, Los Alamos National Laboratory
LMW, Low Molecular Weight
NA, Not applicable.
NE, Not evaluated.
ORNL, Oak Ridge National Laboratory Benchmarks
PAH, Polycyclic Aromatic Hydrocarbons
SLERA, Screening-Level Ecological Risk Assessment
$TEC_{2,3,7,8\text{-}TCDD}$, Toxicity equivalency concentration - 2,3,7,8-TCDD
USEPA, United States Environmental Protection Agency

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Analyte	CAS Number	log K_{ow}	Minimum CFAC SLERA ESV	Refined CFAC BERA ESV	Threshold Effects Ecological Screening Values					
					Consensus-based Threshold Effect Concentration (TEC) (MacDonald et al., 2000)	USEPA Region 5 RCRA Ecological Screening Levels	USEPA Region 3 BTAG Freshwater Sediment Screening Benchmarks	TEL-HA28 (USEPA, 1996; Ingersoll et al., 1996)	USEPA ESBs PAHs (USEPA, 2003d) Coc, PAHi,FCVi (mg/kg @ 1% TOC)	USEPA ESBs Nonpolar Organics (USEPA, 2008c) (mg/kg @ 1% TOC)
Metals (mg/kg)										
Aluminum	7429905	NA	26000	26000	--	--	--	26000	--	--
Antimony	7440360	NA	2	2	--	--	2	--	--	--
Arsenic	7440382	NA	9.79	9.79	9.79	9.79	9.8	10.787	--	--
Barium	7440393	NA	No ESV	No ESV	--	--	--	--	--	--
Beryllium	7440417	NA	No ESV	No ESV	--	--	--	--	--	--
Cadmium	7440439	NA	0.583	0.99	0.99	0.99	0.99	0.583	--	--
Chromium	7440473	NA	36.2	43.4	43.4	43.4	43.4	36.2	--	--
Cobalt	7440484	NA	50	50	--	50	50	--	--	--
Copper	7440508	NA	28	31.6	31.6	31.6	31.6	28	--	--
Iron	7439896	NA	20000	20000	--	--	20000	188400	--	--
Lead	7439921	NA	35.8	35.8	35.8	35.8	35.8	37.2	--	--
Manganese	7439965	NA	460	460	--	--	460	631	--	--
Mercury	7439976	NA	0.174	0.18	0.18	0.174	0.18	--	--	--
Nickel	7440020	NA	19.5	22.7	22.7	22.7	22.7	19.5	--	--
Selenium	7782492	NA	2	2	--	--	2	--	--	--
Silver	7440224	NA	0.5	0.5	--	0.5	1	--	--	--
Thallium	7440280	NA	No ESV	No ESV	--	--	--	--	--	--
Vanadium	7440622	NA	No ESV	No ESV	--	--	--	--	--	--
Zinc	7440666	NA	98	121	121	121	121	98	--	--
Essential Nutrients (mg/kg)										
Calcium	7440702	NA	No ESV	Background	--	--	--	--	--	--
Magnesium	7439954	NA	No ESV	Background	--	--	--	--	--	--
Potassium	7440097	NA	No ESV	Background	--	--	--	--	--	--
Sodium	7440235	NA	No ESV	Background	--	--	--	--	--	--
Other Inorganic Parameters (mg/kg)										
Cyanide, Total	57125	NA	0.0001	0.1	--	0.0001	0.1	--	--	--
Polycyclic Aromatic Hydrocarbons (PAHs) (mg/kg)										
2-Methylnaphthalene	91576	3.72	0.0202	Equilibrium Partitioning Sediment Benchmark ($\sum ESBTU_{FCV,Total}$) approach based on sample-specific organic carbon content (USEPA, 2003d; see text)	--	0.0202	0.0202	--	4.47	--
Acenaphthene	83329	4.01	0.00671		--	0.00671	0.00671	--	4.91	--
Acenaphthylene	208968	3.22	0.00587		--	0.00587	0.0059	--	4.52	--
Anthracene	120127	4.53	0.01		0.0572	0.0572	0.0572	0.01	5.94	--
Fluorene	86737	4.21	0.01		0.0774	0.0774	0.0774	0.01	5.38	--
Naphthalene	91203	3.36	0.015		0.176	0.176	0.176	0.015	3.85	--
Phenanthrene	85018	4.57	0.019		0.204	0.204	0.204	0.019	5.96	--
Total LMW PAHs	NA	NA	0.076		--	--	0.076	0.076	--	--
Benzo(a) pyrene	50328	6.11	0.032		0.15	0.15	0.15	0.032	9.65	--

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					Consensus-based Threshold Effect Concentration (TEC) (MacDonald et al., 2000)	USEPA Region 5 RCRA Ecological Screening Levels	USEPA Region 3 BTAG Freshwater Sediment Screening Benchmarks	TEL-HA28 (USEPA, 1996; Ingersoll et al., 1996)	USEPA ESBs PAHs (USEPA, 2003d) Coc, PAHi,FCVi (mg/kg @ 1% TOC)	USEPA ESBs Nonpolar Organics (USEPA, 2008c) (mg/kg @ 1% TOC)
Benzo(a)anthracene	56553	6.71	0.016	Equilibrium Partitioning Sediment Benchmark ($\sum ESBTU_{FCV,Total}$) approach based on sample-specific organic carbon content (USEPA, 2003d; see text)	0.108	0.108	0.108	0.016	8.41	--
Benzo(b) fluoranthene	205992	6.27	10.4		--	10.4	--	--	9.79	--
Benzo(g,h,i) perylene	191242	6.51	0.016		--	0.17	0.17	0.016	10.95	--
Benzo(k) fluoranthene	207089	6.29	0.24		--	0.24	0.24	--	9.81	--
Chrysene	218019	5.71	0.027		0.166	0.166	0.166	0.027	8.44	--
Dibenzo(a,h) anthracene	53703	6.71	0.01		0.033	--	0.033	0.01	11.23	--
Indeno(1,2,3,-cd) pyrene	193395	6.72	0.017		--	0.2	0.017	0.017	11.15	--
Fluoranthene	206440	5.08	0.031		0.423	0.423	0.423	0.031	7.07	--
Pyrene	129000	4.92	0.044		0.195	0.195	0.195	0.044	6.97	--
Total HMW PAHs	NA	NA	0.19		--	--	0.19	0.19	--	--
Total PAHs	NA	NA	0.26		1.61	--	1.61	0.26	--	--
Semi-Volatile Organic Compounds (SVOCs) - Non PAH (mg/kg)										
Acetophenone	98862	1.67	No ESV	No ESV	--	--	--	--	--	--
Benzaldehyde	100527	1.71	No ESV	No ESV	--	--	--	--	--	--
Bis(2-chloroethyl) ether	111444	1.56	No ESV	No ESV	--	--	--	--	--	--
Carbazole	86748	3.29	No ESV	No ESV	--	--	--	--	--	--
Dibenzofuran	132649	3.71	0.300736	17 @ 1 % OC	--	0.449	0.415	--	--	17
Methylphenol, 3 & 4	106445	2.06	No ESV	0.0202	--	0.0202	--	--	--	--

Notes:

No ESV, An ecological screening value was not identified from the listed sources.
$\sum ESBTU_{FCV,Total}$, Equilibrium-Partitioning Sediment Benchmark Toxic Units based on final chronic values (FCVs)
BERA, Baseline Ecological Risk Assessment
BTAG, Biological Technical Assistance Group
CFAC, Columbia Falls Aluminum Company
ESB, Equilibrium Partitioning Sediment Benchmark
ESV, Ecological Screening Value
HMW, High Molecular Weight
LMW, Low Molecular Weight
NA, Not applicable.
NE, Not evaluated.
OC, Organic carbon
PAH, Polycyclic Aromatic Hydrocarbons
RCRA, Resource Conservation and Recovery Act
SLERA, Screening-Level Ecological Risk Assessment
TEC, Threshold Effect Concentration
TEL-HA28, Threshold effect level - *Hyalella azteca* 28-day test
TOC, Total organic carbon

Table 3
Summary of Refined Ecological Screening Values (ESVs) for Surface Water
Technical Memorandum: Proposed Refined Ecological Screening Values
Columbia Falls Aluminum Company
Columbia Fall, Montana

Analyte	CAS Number	Fraction	Minimum CFAC SLERA ESV	Refined CFAC BERA ESV	Refined ESV Basis	DEQ-7 Aquatic Life Standard	USEPA National Recommended Water Quality Criteria	USEPA Region 3 Freshwater Screening Benchmark	Toxicological Benchmarks for Screening Potential Contaminants of Concern for Effects on Aquatic Biota (Suter and Tsao, 1996)		Canadian Water Quality Guidelines (CCME)
									Lowest Chronic Value - All Organisms	Tier II Secondary Chronic Values	
Metals (µg/L)											
Aluminum	7429905	D	87	87 (pH 6.5-9)	DEQ-7	87 (pH 6.5-9)	--	87	460	--	--
		T	87	2017 Draft Freshwater Chronic Criteria	USEPA (2017)	--	87 (pH 6.5-9)	--	--	--	--
Barium	7440393	D	4	4	Suter and Tsao (1996)	--	--	4	--	4	--
		T	4	--	--	--	--	--	--	--	--
Beryllium	7440417	D	0.66	5.3	Suter and Tsao (1996)	--	--	0.66	5.3	0.66	--
		T	0.66	--	--	--	--	--	--	--	--
Cadmium	7440439	D	0.09	0.25 (h)	NRWQC	--	0.25 (h)	--	0.15	--	0.09
		T	0.09	0.25 (h)	DEQ-7	0.25 (h)	--	--	--	--	--
Copper	7440508	D	0.23	USEPA Biotic Ligand Model (BLM)	USEPA (2007)	--	Biotic Ligand Model (BLM)	9	0.23	--	--
		T	0.23	2.85 (h)	DEQ-7	2.85 (h)	--	--	--	--	--
Iron	7439896	D	158	--	--	--	--	300	158	--	300
		T	158	1000	NRWQC/DEQ-7	1000	1000	--	--	--	--
Lead	7439921	D	0.54	0.54 (h)	NRWQC	--	0.54 (h)	2.5	12.26	--	--
		T	0.54	0.54 (h)	DEQ-7	0.54 (h)	--	--	--	--	--
Manganese	7439965	D	120	1100	Suter and Tsao (1996)	--	--	120	1100	120	--
		T	120	--	--	--	--	--	--	--	--
Nickel	7440020	D	5	16.1 (h)	NRWQC	--	16.1 (h)	52	5	--	--
		T	5	16.1 (h)	DEQ-7	16.1 (h)	--	--	--	--	--
Zinc	7440666	D	30	36.5 (h)	NRWQC	--	36.5 (h)	120	30	--	30
		T	30	37 (h)	DEQ-7	37 (h)	--	--	--	--	--
Other Inorganic Parameters (µg/L)											
Cyanide, Total	57125	T	5.2	5.2	DEQ-7	5.2	--	5	7.8	--	5
Cyanide, Free	STL02227	T	5.2	5.2	NRWQC	--	5.2	--		--	--
Fluoride	16984488	T	120	120	CCME	--	--	--	--	--	120

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Columbia Falls Aluminum Company
Columbia Fall, Montana

Analyte	CAS Number	Fraction	Minimum CFAC SLERA ESV	Refined CFAC BERA ESV	Refined ESV Basis	DEQ-7 Aquatic Life Standard	USEPA National Recommended Water Quality Criteria	USEPA Region 3 Freshwater Screening Benchmark	Toxicological Benchmarks for Screening Potential Contaminants of Concern for Effects on Aquatic Biota (Suter and Tsao, 1996)		Canadian Water Quality Guidelines (CCME)
									Lowest Chronic Value - All Organisms	Tier II Secondary Chronic Values	
Polycyclic Aromatic Hydrocarbons (PAHs) (µg/L)											
Benzo(a) pyrene	50328	T	0.014	0.3	Suter and Tsao (1996)	--	--	0.015	0.3	0.014	0.015
Benzo(a)anthracene	56553	T	0.018	0.65	Suter and Tsao (1996)	--	--	0.018	0.65	0.027	0.018
Benzo(b) fluoranthene	205992	T	No ESV	No ESV	--	--	--	--	--	--	--
Benzo(g,h,i) perylene	191242	T	No ESV	No ESV	--	--	--	--	--	--	--
Chrysene	218019	T	No ESV	No ESV	--	--	--	--	--	--	--
Fluoranthene	206440	T	0.04	15	Suter and Tsao (1996)	--	--	0.04	15	--	0.04
Indeno(1,2,3,-cd) pyrene	193395	T	No ESV	No ESV	--	--	--	--	--	--	--
Phenanthrene	85018	T	0.4	200	Suter and Tsao (1996)	--	--	0.4	200	--	0.4
Pyrene	129000	T	0.025	0.025	--	--	--	0.025	--	--	0.025

Notes:

No ESV, An ecological screening value was not identified from the listed sources.

D, Dissolved (filtered) fraction

T, Total (unfiltered) fraction

--, No value available.

(d), Criterion based on dissolved fraction.

(h), Hardness-dependent criterion estimated at a total hardness values of 25 mg/L as $CaCO_3$ based on the following equations:

Metal	MDEQ exp.{mc[ln(hardness)]+bc}		NRWQC exp{mC [ln(hardness)]+ bC} (CF)		
	mc	bc	mc	bc	CF
Cadmium	0.7977	-3.909	0.7977	-3.909	1.101672-[(lnhardness)(0.041838)]
Copper	0.8545	-1.702	Biotic Ligand Model		
Lead	1.273	-4.705	1.273	-4.705	1.46203-[(lnhardness)(0.145712)]
Nickel	0.846	0.0584	0.846	0.0584	0.997
Zinc	0.8473	0.884	0.8473	0.884	0.986

BERA, Baseline Ecological Risk Assessment
BLM, Biotic ligand model.
CCME, Canadian Council of Ministers of the Environment
CFAC, Columbia Falls Aluminum Company
DEQ-7, Montana Department of Environmental Quality Circular DEQ-7 Montana Numeric Water Quality Standards
ESV, Ecological Screening Value
NRWQC, National Recommended Water Quality Criteria
SLERA, Screening-Level Ecological Risk Assessment
USEPA, United States Environmental Protection Agency